

**MARK-RECAPTURE ESTIMATES OF THE NUMBER OF RECREATIONAL VESSELS FISHING  
FOR LARGE PELAGICS OFF THE NORTHEAST UNITED STATES**

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**SUMMARY**

Estimates of the number of private and charter vessels currently fishing for large pelagic species off the Virginia coast were obtained via an application of the familiar Lincoln-Petersen mark-recapture model. Sub-populations of vessels from each state, obtained from a telephone list employed by an earlier survey, were treated as the marked population. Vessels interviewed at randomly-selected access points were treated as the captured population. The Petersen estimate of fleet size was then obtained by multiplying the number of marked vessels by the ratio of the number of captured vessels to the number of marked vessels that were marked. Three variations of the approach were computed to account for situations where several boats may share the same name or one boat may have several captains. The results indicate that there were about 100 charter and 2000 private vessels operating off Virginia during July and August of 1992.

**RESUME**

Les estimations du nombre de bateaux privés et en location qui pêchent actuellement des espèces de grands pélagiques au large de la côte de Virginie ont été obtenues en utilisant le modèle classique de marquage-recapture Lincoln-Petersen. Les sous populations de bateaux de chaque état, obtenues à travers une liste téléphonique employée lors d'une prospection antérieure, ont été traitées comme population marquée. Les bateaux interviewés dans des points d'accès sélectionnés au hasard ont été traités comme population capturée. L'estimation de Petersen de l'ampleur de la flottille a ensuite été obtenu en multipliant le nombre de bateaux marqués par le rapport du nombre de bateaux capturés au nombre de bateaux capturés qui étaient marqués. Trois variations de la méthode ont été calculées pour rendre compte des situations lorsque plusieurs bateaux doivent partager le même nom ou qu'un bateau peut avoir plusieurs capitaines. Les résultats indiquent qu'en juillet et août 1992, il a eu environ 100 bateaux en location et 2.000 bateaux privés qui ont pêché au large de Virginie.

**RESUMEN**

Se obtuvieron estimaciones del número de barcos de propiedad privada o alquilados que capturan en la actualidad grandes especies pelágicas frente a las costas de Virginia, mediante una aplicación del conocido modelo de marcado-recaptura de Lincoln-Petersen. Las subpoblaciones de barcos de cada estado, obtenidas de una lista telefónica utilizada en una prospección anterior, se trataron como población marcada. Los barcos entrevistados en puntos de acceso seleccionados aleatoriamente se trataron como población capturada. La estimación de Petersen del tamaño de la flota se obtuvo multiplicando el número de barcos marcados por la razón del número de barcos capturados respecto al número de barcos capturados que estaban marcados. Se computaron tres variaciones del enfoque, para explicar situaciones en las cuales varios barcos podrían tener el mismo nombre, o un barco varios capitanes. Los resultados indican que había unos 100 barcos alquilados y 2.000 barcos de propiedad privada faenando frente a Virginia durante julio y agosto de 1992.

**Methods**

The numbers of private and charter vessels fishing for large pelagic fish off Virginia,  $N_v$ , were estimated using the Lincoln-Petersen model,

$$N_v = M_v \frac{n_v}{m_v}$$

where  $M_v$  is the number of vessels marked (by vessel type  $v$ ),  $n_v$  is the number of vessels "captured", and  $m_v$  is the number of captured vessels that were marked. The marked population consisted of those vessels on a master telephone list, derived from previous surveys, that had been contacted at least once during the course of the 1992 survey. The "captured" vessels were those interviewed at randomly selected dock-side gas pumps and boat ramps.

Estimates were made using data pooled across waves (weeks), therefore unique vessels were counted only once. The interview data used to generate the appropriate tallies, however, was imperfect. Accordingly, the following decision rules were adopted:

1. If a boat had no name, no LPS number, no state registration number, and no coast guard number, it was dropped.

Rationale. There was no way to identify whether the boat was marked or whether it was unique.

2. If a boat had no name and no LPS number, but either a state registration number or a coast guard number, it was included.

Rationale. This type of boat was considered a unique boat without a name.

3. If two or more boats had the same name but different LPS numbers and no Coast Guard or state registration number, judgement was used to determine if they were unique.

Rationale. There were instances of (1) different vessels with the same name and (2) the same vessel with different LPS numbers on the marked list.

4. For named boats without LPS numbers two sets of tallies were made, one matching by boat name and captain name, the second matching only by boat name. For the latter matching system the number of vessels considered marked was reduced by the number of vessels on the marked list with duplicate names.

Three approaches were used to estimate the number of vessels in the recreational fleet.

The first approach equates the number of captured vessels (n) with the number of unique vessels interviewed and equates the number of captured vessels that were marked (m) with the number of unique vessel interviews that could be matched with the mark list by either their LPS number or the combination of the vessel's name plus its captain's name. The second approach also equates n with the number of unique vessels, but considers two interviews with the same boat name to be for the same boat unless they have different state registration or Coast Guard numbers. Similarly, the number of marked captures is taken as the number of unique vessel interviews that could be matched with the mark list by LPS number or vessel name. When the second approach was used, the mark list was also collapsed by vessel name inasmuch as the Coast Guard and state registration numbers were not recorded when the mark list was generated. The first system, which uses both boat name and captain name for vessels without LPS numbers, results in an overestimate of fleet size if more than one captain might run a boat. The second system, which uses only boat name for vessels without LPS numbers, results in an underestimate if multiple boats have the same name.

The third approach used the Lincoln-Petersen estimator to estimate the number of vessel names in the fleet, specifically excluding vessels without names in the tallies. This estimate was in turn multiplied by a correction factor, c, obtained from the subset of interviews where state registration numbers were recorded-- the number of unique vessels (as identified by their state registration numbers) divided by the number of unique vessels with names. This correction factor implicitly includes adjustments for vessels without a name as well as multiple boats with the same name, hence the corresponding estimate total fleet size should be less biased than either of the estimates produced by the first two approaches discussed under provided the likelihood of a clerk recording the state registration number is independent of whether or not the interviewed vessel has a name. This problem was treated by estimating the respective probabilities directly from the data and multiplying the correction factor by their ratio:

$$p(\text{record}) = \frac{I_{SR}}{I}$$

$$p(\text{record}|\text{name}) = \frac{I_{SR+\text{name}}}{I_{\text{name}}}$$

$$c_{\text{new}} = c \frac{P(\text{record}|\text{name})}{p(\text{record})}$$

where p(.) represents the estimate of probability,  $I_{SR}$  represents the number of interviews with state registration (SR) numbers, I is the number of interviews,  $I_{SR+\text{name}}$  is the number of interviews with SR numbers and names and  $I_{\text{name}}$  the number of interviews with names.

## Results

The estimates of fleet size corresponding to the three approaches are summarized in tables 1 and 2. The estimate obtained with only a single week's data appears unrealistically high, however the estimates quickly stabilize to around 2,200 private vessels and 97 charter vessels. The estimates based on the first approach (matched by vessel name and captain name) are substantially higher than those based on the second and third approaches, as expected. The estimates based on the second and third approach are generally very similar, suggesting that there are relatively few names common to more than one vessel in Virginia.

Table 1. Mark-recapture data from private vessels contacted at gas pumps and ramps through 28 July 1992 and associated estimates of fleet size. Columns marked "LPS" refer to vessels identified by the Large Pelagic Survey Number or, in the absence of that number, by the names of the boat and captain. Columns marked "boat" refer to vessels identified solely by their name (boats that do not have a name are excluded from these tallies). The column labeled "b/sr" refers to vessels identified as unique by their name and, when available, the state registration number. Three hundred and thirty five private LPS numbers (331 boat names) were marked.

wave	unique contacts			marked contacts		correction factor	estimated fleet		
	b/sr	boat	LPS	boat	LPS		b/sr	boat	LPS
3 (6/1-6/7)	26	20	26	2	1	1.30	4,303	4,303	8,710
4 (6/1-6/14)	88	74	89	13	12	1.19	2,234	2,238	2,477
5 (6/1-6/21)	138	117	141	24	22	1.19	1,903	1,923	2,147
6 (6/1-6/28)	210	177	215	34	31	1.19	2,057	2,071	2,337
7 (6/1-7/5)	297	245	303	46	42	1.22	2,137	2,147	2,417
8 (6/1-7/12)	318	263	327	49	45	1.22	2,148	2,160	2,434
9 (6/1-7/19)	347	291	357	53	49	1.19	2,167	2,162	2,441
10 (6/1-7/26)	362	303	374	53	49	1.20	2,261	2,265	2,557

Table 2. Mark-recapture data from charter vessels contacted at gas pumps and ramps through 28 July 1992 and associated estimates of fleet size. Columns marked "LPS" refer to vessels identified by the Large Pelagic Survey Number or, in the absence of that number, by the names of the boat and captain. Columns marked "boat" refer to vessels identified solely by their name (boats that do not have a name are excluded from these tallies). The column labeled "b/sr" refers to vessels identified as unique by their name and, when available, the state registration number. Forty seven charter boats were marked.

wave	unique contacts			marked contacts		correction factor	estimated fleet		
	b/sr	boat	LPS	boat	LPS		b/sr	boat	LPS
3 (6/1-6/7)	0	0	0	0	0	----	--	--	--
4 (6/1-6/14)	2	2	2	1	1	1.00	96	96	96
5 (6/1-6/21)	12	12	12	6	6	1.00	94	94	94
6 (6/1-6/28)	16	16	16	8	8	1.00	90	90	90
7 (6/1-7/5)	23	23	24	13	11	1.00	83	83	103
8 (6/1-7/12)	27	27	29	14	13	1.00	91	91	105
9 (6/1-7/19)	29	29	31	14	13	1.00	97	97	112
10 (6/1-7/26)	29	29	31	14	13	1.00	97	97	112